CLAIMS

1. A knob controller device comprising:

a knob coupled to a grounded surface, said knob rotatable in a rotary degree of freedom about an axis extending through said knob, said knob also moveable in a transverse direction approximately perpendicular to said axis;

a rotational sensor that detects a position of said knob in said rotary degree of freedom;

a transverse sensor operative to detect a position of said knob in said transverse direction; and

an actuator coupled to said knob and operative to output a force in said rotary degree of freedom about said axis.

2. A knob controller device as recited in claim 1 wherein said knob is also moveable in a linear degree of freedom approximately parallel to said axis, and further comprising a linear sensor operative to detect a position of said knob in said linear degree of freedom.

3. A knob controller device as recited in claim 2 wherein said knob can be pushed by a user, said pushing motion being detected by said linear sensor.

4. A knob controller device as recited in claim 2 wherein said knob can be pulled by a user, said pulling motion being detected by said linear sensor.

5. A knob controller device as recited in claim 1 wherein said knob is moveable in a plurality of transverse directions, and wherein said transverse sensor is operative to detect when said knob is moved in any of said transverse directions.

6. A knob controller device as recited in claim 1 wherein said transverse sensor includes a hat switch having a plurality of individual switches, each of said individual switches detecting movement of said knob in a particular transverse direction.

7. A knob controller device as recited in claim 6 wherein said knob is moveable in four transverse directions spaced approximately orthogonal to each other, and wherein said hat switch includes four individual switches.

8. A knob controller device as recited in claim 1 further comprising a microprocessor coupled to said rotational sensor and to said transverse sensor, said microprocessor receiving sensor signals from said sensors and controlling a function of a device in response to said sensor signals.

9. A knob controller device as recited in claim 8 wherein said device is an audio device.

10. A knob controller device as recited in claim 1 further comprising a microprocessor coupled to said rotational sensor and to said transverse sensor, said microprocessor receiving sensor signals from said sensors and controlling a function of a device in response to said sensor signals, said microprocessor sending force feedback signals to said actuator to control forces output by said actuator.

11. A knob controller device as recited in claim 1 further comprising a display, wherein an image on said display is changed in response to manipulation of said knob in said transverse direction.

12. A knob controller device as recited in claim 1 wherein a flexible member is coupled between said knob and said actuator to allow said movement in said tranverse direction.

13. A knob controller device as recited in claim 12 wherein said flexible member is a spring member.

14. A knob controller device as recited in claim 12 wherein said flexible member includes a base plate and a plurality of bent flexible portions coupled to said base plate.

15. A knob controller device comprising:

a knob coupled to a grounded surface, said knob rotatable in a rotary degree of freedom about an axis extending through said knob, said knob also moveable in a linear degree of freedom approximately parallel to said axis;

a rotational sensor that detects a position of said knob in said rotary degree of freedom;

a linear sensor that detects a position of said knob in said linear degree of freedom; and

an actuator coupled to said knob and operative to output a force in said rotary degree of freedom about said axis.

16. A knob controller device as recited in claim 15 further comprising a microprocessor coupled to said rotational sensor and to said linear sensor, said microprocessor receiving sensor signals from said sensors and controlling a function of a device in response to said sensor signals, said microprocessor sending force feedback signals to said actuator to control forces output by said actuator.

17. A knob controller device as recited in claim 15 wherein said knob can be pushed by a user, said pushing motion being detected by said linear sensor.

18. A knob controller device as recited in claim 15 wherein said knob can be pulled by a user, said pulling motion being detected by said linear sensor.

19. A knob controller device as recited in claim 15 wherein said knob can be pushed or pulled by a user, said pushing motion and said pulling motion being detected by said linear sensor.

20. A knob controller device as recited in claim 15 said knob is also moveable in a plurality of transverse directions approximately perpendicular to said axis, and further comprising a transverse sensor operative to detect movement of said knob in any of said transverse directions.

21. A knob controller device as recited in claim 15 further comprising a spring member for biasing said knob to a center position in said linear degree of freedom.

22. A knob controller device as recited in claim 15 wherein said linear sensor includes a grounded switch that is contacted by a pusher member coupled to said knob when said knob is moved in said linear degree of freedom.

23. A knob controller device as recited in claim 15 wherein said linear sensor detects a position of said knob within a detectable continuous range of motion of said knob, and wherein said linear sensor outputs a sensor signal indicative of said position.

24. A method for controlling functions of a device from input provided by a knob, the method comprising:

reading a rotary sensor signal from a rotary sensor, said rotary sensor signal being representative of a position of a knob in a rotary degree of freedom about an axis extending through said knob;

reading a transverse switch signal from a transverse switch, said transverse switch signal indicating when said knob is moved in a transverse degree of freedom approximately perpendicular to said axis;

using at least one of said rotary sensor signal and said transverse switch signal to control at least one function of said device; and

providing a force feedback signal to an actuator that is coupled to said knob, said force feedback signal being based at least in part on said rotary sensor signal.

25. A method as recited in claim 24 further comprising reading a linear sensor signal from a linear sensor, said linear sensor signal being representative of a position of said knob in a linear degree of freedom approximately parallel to said axis.

26. A method as recited in claim 25 wherein said function of said device includes at least one of adjusting a frequency of a radio tuner, adjusting a temperature in an area, and controlling a physical position of a mechanical component.

27. A method as recited in claim 24 wherein said function of said device includes adjusting a displayed image based on at least one said rotary sensor signal and said transverse switch signal.

28. An interface control device including force feedback and providing rate control and position control modes, the interface control device comprising:

a user manipulatable object grasped by a user and movable in a degree of freedom;

an actuator coupled to said user manipulatable object and providing forces on said user manipulatable object in said degree of freedom;

a sensor that detects a position of said user manipulatable object in said degree of freedom and outputs a sensor signal including information representing said position;

a microprocessor coupled to said actuator and to said sensor, said microprocessor controlling said forces provided by said actuator and receiving said sensor signal from said sensor, wherein said microprocessor commands either a position control mode or a rate control mode for said user manipulatable object, wherein said position control mode controls a value based on a position of said user manipulatable object in said degree of freedom, and wherein said rate control mode controls a rate of change of said value based on a position of said user manipulatable object in said degree of freedom.

29. An interface control device as recited in claim 28 wherein said degree of freedom is a rotary degree of freedom, and wherein said user manipulatable object includes a rotary knob.

30. An interface control device as recited in claim 28 wherein said degree of freedom is a linear degree of freedom, and wherein said user manipulatable object includes a slider control knob.

31. An interface control device as recited in claim 28 wherein said rate control mode provides a force on said user manipulatable object using said actuator, said force being applied in a direction opposing a movement of said user manipulatable object away from an origin position.

32. An interface control device as recited in claim 28 wherein said force opposing said movement is a spring force.

33. An interface control device as recited in claim 28 wherein said microprocessor controls said actuator to output at least one force detent during movement of said knob in said position control mode.

34. An interface control device as recited in claim 28 wherein said rate of change is related to a displacement of said user manipulatable with respect to an origin position.

35. An interface control device as recited in claim 28 wherein said rate control mode is used to control the value of a volume, bass, treble, or balance function of said device.

36. An interface control device as recited in claim 28 wherein said position control mode is used to control the value of a volume, bass, treble, or balance function of said device.

37. An interface control device as recited in claim 28 wherein said rate control mode is used to control a position of a physical component in a vehicle.

38. A method for providing detent forces for a force feedback control, the method comprising:

outputting a first force for a first detent on a user manipulatable object contacted by a user and moveable in a degree of freedom, said first force being output when said user manipulatable object is moved within a range of said first detent, said first force being output by a electronically-controlled actuator, wherein said first force assists movement of said user manipulatable object toward an origin position of said first detent and wherein said first force resists movement of said user manipulatable object away from said origin position of said first detent; and

outputting a second force for a second detent on said user manipulatable object when said user manipulatable object is moved within a range of said second detent, said second force being output by said actuator and said second detent having an origin position different from said origin position of said first detent, wherein said second force assists movement of said user manipulatable object toward an origin position of said second detent and wherein said second force resists movement of said user manipulatable object away from said origin position of said second detent, wherein a portion of said range of said first detent overlaps a portion of said range of said second detent.

39. A method as recited in claim 38 wherein said first force for said first detent has a magnitude that increases the further that said user manipulatable object is positioned from said origin of said first detent, and wherein said second force for said second detent has a magnitude that increases the further that said user manipulatable object is positioned from said origin of said second detent.

40. A method as recited in claim 38 wherein a deadband is provided around said origin of said first detent and around said origin of said second detent, wherein a magnitude of said first force and said second force is zero when said user manipulatable object is positioned within said deadband.

41. A method as recited in claim 38 wherein when said user manipulatable object is moved in a particular direction from said first detent to said second detent, said first detent range has an endpoint positioned after a beginning point of said second detent range such that a force at said beginning point of said second detent range has less magnitude than a force at an endpoint of said second detent range.

42. A method as recited in claim 41 wherein when said user manipulatable object is moved in a direction opposite to said particular direction from said second detent to

said first detent, a force at a first-encountered point of said first detent range has less magnitude than a force at a last-encountered point of said first detent range.

43. A method as recited in claim 41 wherein said first detent range does not overlap past said origin of said second detent.

44. A method as recited in claim 38 wherein said user manipulatable object is a knob and said degree of freedom is a rotary degree of freedom.

45. A method for providing detent forces for a force feedback control, the method comprising:

defining a periodic wave;

using at least a portion of said periodic wave to define a detent force curve, said detent force curve defining a force to be output on a user manipulatable object based on a position of said user manipulatable object in a degree of freedom, said user manipulatable object being contacted and moveable by a user; and

using said detent force curve to command said force on said user manipulatable object, said force being output by a electronically-controlled actuator.

46. A method as recited in claim 45 wherein said defining a periodic wave includes specifying a type, a period and a magnitude for said periodic wave.

47. A method as recited in claim 45 wherein said using at least a portion of said periodic wave to define a detent force curve includes specifying a portion of said periodic wave to define a width of said detent force curve.

48. A method as recited in claim 47 wherein said using at least a portion of said periodic wave to define a detent force curve includes specifying a phase and an offset to be applied to said periodic wave to define said detent force curve.

49. A method as recited in claim 45 wherein said using at least a portion of said periodic wave to define a detent force curve includes specifying an increment distance, wherein successive detent force curves in said degree of freedom are spaced apart by said increment distance.

50. A method as recited in claim 45 wherein said user manipulatable object is a knob moveable in a rotary degree of freedom.